

- 2 -

Accordingly the invention may broadly be said to consist in an amplification system for a radio transmitter comprising: a processing subsystem which determines envelope information and phase information from a baseband input signal, a phase modulator which generates a substantially constant amplitude signal having phase determined by the phase information, an envelope modulator which generates an amplitude modulation signal determined by the envelope information, and an amplifier which generates an output signal from the constant amplitude signal and the amplitude modulation signal.

- 10 The phase modulator may include a PLL or other such as a quadrature modulator. The PLL preferably includes a frequency divider which is modulated according to the phase information. Preferably the envelope modulator includes a pulse width modulator or a sigma delta modulator.
- 15 The processing subsystem may modify the envelope or phase information according to various forms of Cartesian feedback from the output signal from the amplifier. The processing subsystem may also or alternatively provide a predistort signal to the phase modulator or the envelope modulator in a variety of ways.
- 20 The invention may also broadly be said to consist in any alternative combination of features which are suggested in this specification. All equivalents of these features are included.

#### BRIEF LIST OF FIGURES

25

Preferred embodiments of the invention will be described with reference to the drawings of which:

Figure 1 schematically shows a radio transmitter with amplification of a signal by a polar loop feedback system,

30

Figure 2 shows an amplification system in a general form according to the invention,

Figure 3 shows one embodiment of the system with Cartesian feedback,

Figure 4 shows another embodiment of the system with feedback for predistortion,

Figure 5 shows an alternative embodiment of the system with feedback for predistortion,

Figure 6 shows another embodiment with phase modulation by way of a phase lock loop,

- 5        Figure 7 shows a PLL arrangement for use in the system of Figure 6,  
       Figure 8 shows an alternative embodiment using a phase lock loop,  
       Figure 9 shows a PLL arrangement for use in the system of Figure 8,  
       Figure 10 shows a digital envelope feedback arrangement,  
       Figure 11 shows an analog envelope feedback arrangement.  
10       Figures 12, 13, 14 show amplitude modulators in more detail, and  
       Figure 15 shows a phase modulation arrangement.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

- 15       Referring to the drawings it will be appreciated that the invention may be implemented in various forms and that these embodiments are described by way of example only. Details of existing mobile communication systems will also be known to a skilled reader and need not be given here.
- 20       Figure 1 shows EER implemented in a traditional polar loop system. An incoming RF signal  $I$  is converted by analog block 10 into polar signals  $\Theta$ ,  $r$  respectively containing phase and envelope information. A phase controlled loop including power amplifier 11 operating in saturation then generates an output signal  $S$  according to the information, for transmission by antenna 12. The phase controlled
- 25       loop forms a PLL which receives signal  $\Theta$  and provides a constant amplitude signal to the non-linear amplifier. A power supply to the amplifier receives signal  $r$  and thereby controls gain of the amplifier to restore envelope information and produce signal  $S$ . The PLL includes a phase comparator or detector 13 which compares the phases of signal  $\Theta$  and feedback from signal  $S$  to determine the frequency of a
- 30       voltage controlled oscillator 14. The oscillator in turn provides the constant amplitude signal to the amplifier. Signal  $r$  is also modified by addition in block 15 of feedback from signal  $S$ . The feedback arrangement includes an optional frequency downconverter 16 followed alternatively for signals  $\Theta$ ,  $r$  by an amplitude limiter 16 and envelope detector 17.

- 8 -

## CLAIMS:

1. An amplification system for a radio transmitter comprising:  
a processing subsystem which determines envelope information and phase  
5 information from a baseband input signal,  
a phase modulator which generates a substantially constant amplitude signal  
having phase determined by the phase information,  
an envelope modulator which generates an amplitude modulation signal  
determined by the envelope information, and  
10 an amplifier which generates an output signal from the constant amplitude  
signal and the amplitude modulation signal.
2. A system according to claim 1 wherein:  
the phase modulator includes a phase-lock-loop or a quadrature modulator.  
15
3. A system according to claim 1 wherein:  
the envelope modulator includes a pulse width modulator or a sigma delta  
modulator.
- 20 4. A system according to claim 2 wherein:  
the phase-locked-loop includes a frequency divider which is modulated  
according to the phase information.
5. A system according to claim 4 wherein:  
25 the frequency divider is modulated by a sigma-delta modulator which is  
controlled by the processor.
6. A system according to claim 1 wherein:  
the processing subsystem modifies the envelope information according to  
30 Cartesian feedback from the output signal from the amplifier.
7. A system according to claim 1 wherein:  
the processing subsystem modifies the phase information according to  
Cartesian feedback from the output signal from the amplifier.

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8. A system according to claim 1 wherein:  
the processing subsystem predistorts the phase modulation of the output signal according to the envelope information and feedback from the output signal.
- 5 9. A system according to claim 1 wherein:  
the processing subsystem predistorts the phase modulation of the output signal by modifying the phase information.
- 10 10. A system according to claim 1 wherein:  
the amplifier is part of the phase modulator.

# PATENT COOPERATION TREATY

From the:  
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

ALLENS ARTHUR ROBINSON  
GPO BOX 1776Q  
MELBOURNE VIC 3001

**PCT**

NOTIFICATION OF TRANSMITTAL OF  
INTERNATIONAL PRELIMINARY EXAMINATION  
REPORT

(PCT Rule 71.1)

Date of mailing  
day/month/year

23 OCT 2001

Applicant's or agent's file reference  
ALCM:155266

**IMPORTANT NOTIFICATION**

International Application No.  
PCT/NZ00/00189

International Filing Date  
29 September 2000

Priority Date  
29 September 1999

Applicant

TAIT ELECTRONICS LIMITED et al

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translations to those Offices.
4. **REMINDER**  
  
The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices)(Article 39(1))(see also the reminder sent by the International Bureau with Form PCT/IB/301).  
  
Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.  
  
For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide

Name and mailing address of the IPEA/AU

AUSTRALIAN PATENT OFFICE  
PO BOX 200, WODEN ACT 2606, AUSTRALIA  
E-mail address: pct@ipaustalia.gov.au  
Facsimile No. (02) 6285 3929

Authorized officer

R.G. TOLHURST  
Telephone No. (02) 6283 2187

# TENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference <b>ALCM:155266</b>	<b>FOR FURTHER ACTION</b>	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International Application No. <b>PCT/NZ00/00189</b>	International Filing Date ( <i>day/month/year</i> ) <b>29 September 2000</b>	Priority Date ( <i>day/month/year</i> ) <b>29 September 1999</b>
International Patent Classification (IPC) or national classification and IPC  <b>Int. Cl. <sup>7</sup> H03C 5/00; H04L 27/34</b>		
Applicant  <b>TAIT ELECTRONICS LIMITED et al.</b>		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 4 sheets, including this cover sheet.  
☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).  
  
 These annexes consist of a total of 4 sheet(s).
3. This report contains indications relating to the following items:
 

I	<input checked="" type="checkbox"/>	Basis of the report
II	<input type="checkbox"/>	Priority
III	<input type="checkbox"/>	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	<input type="checkbox"/>	Lack of unity of invention
V	<input checked="" type="checkbox"/>	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	<input checked="" type="checkbox"/>	Certain documents cited
VII	<input type="checkbox"/>	Certain defects in the international application
VIII	<input type="checkbox"/>	Certain observations on the international application

Date of submission of the demand <b>19 April 2001</b>	Date of completion of the report <b>18 October 2001</b>
Name and mailing address of the IPEA/AU <b>AUSTRALIAN PATENT OFFICE</b> <b>PO BOX 200, WODEN ACT 2606, AUSTRALIA</b> E-mail address: <b>pct@ipaaustralia.gov.au</b> Facsimile No. (02) 6285 3929	Authorized Officer  <b>R.G. TOLHURST</b> Telephone No. (02) 6283 2187

## I. Basis of the report

1. With regard to the elements of the international application:\*
- ☐ the international application as originally filed.
- ☒ the description, pages 1, 4-7 as originally filed,  
pages , filed with the demand,  
pages 2-3, received on 6 July 2001 with the letter of 6 July 2001
- ☒ the claims, pages , as originally filed,  
pages , as amended (together with any statement) under Article 19,  
pages , filed with the demand,  
pages 8-9, received on 6 July 2001 with the letter of 6 July 2001
- ☒ the drawings, pages 1/9-9/9, as originally filed,  
pages , filed with the demand,  
pages , received on with the letter of
- ☐ the sequence listing part of the description:  
pages , as originally filed  
pages , filed with the demand  
pages , received on with the letter of
2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.  
These elements were available or furnished to this Authority in the following language which is:
- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).
3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:
- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished
4. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/fig.
5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).\*\*

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. Statement**

Novelty (N)	Claims 1-8	YES
	Claims	NO
Inventive step (IS)	Claims 2-8	YES
	Claims 1	NO
Industrial applicability (IA)	Claims 1-8	YES
	Claims	NO

**2. Citations and explanations (Rule 70.7)**

As amended claim 1 defines arrangements in which the phase modulator includes: (i) a PLL which includes a frequency divider etc, or, alternatively, (ii) a quadrature modulator, otherwise not characterised. The latter configuration is considered to be non-inventive over the cited EP 360178, when read in view of what is well known in the field.



## VI. Certain documents cited

## 1. Certain published documents (Rule 70.10)

Application No. Patent No.	Publication date (day/month/year)	Filing date (day/month/year)	Priority date ( valid claim) (day/month/year)
WO 99/54994	28 October 1999	29 September 1998	21 April 1998

## 2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure	Date of non-written disclosure (day/month/year)	Date of written disclosure referring to non- written disclosure (day/month/year)
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# PATENT COOPERATION TREATY

## PCT

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pages , filed with the demand,  
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- ☐ the sequence listing part of the description:  
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	Claims	NO
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	Claims 1	NO
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Kind of non-written disclosure	Date of non-written disclosure (day/month/year)	Date of written disclosure referring to non- written disclosure (day/month/year)
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## BRIEF LIST OF FIGURES

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Figure 2 shows an amplification system in a general form according to the invention,

Figure 3 shows one embodiment of the system with Cartesian feedback,

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Figure 15 shows a phase modulation arrangement.

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CLAIMS:

1. An amplification system for a radio transmitter comprising:

5 a processing subsystem which determines envelope information and phase information from a baseband input signal,

a phase modulator which generates a substantially constant amplitude signal having phase determined by the phase information,

an envelope modulator which generates an amplitude modulation signal determined by the envelope information, and

10 an amplifier which generates an output signal from the constant amplitude signal, and the amplitude modulation signal,

wherein the phase modulator includes a phase-lock-loop or a quadrature modulator, and the phase-lock-loop includes a frequency divider which is modulated according to the phase information.

15

2. A system according to claim 1 wherein:

the envelope modulator includes a pulse width modulator or a sigma delta modulator.

20 3. A system according to claim 1 wherein:

the frequency divider is modulated by a sigma-delta modulator which is controlled by the processing subsystem.

4. A system according to claim 1 wherein:

25 the processing subsystem modifies the envelope information according to Cartesian feedback from the output signal from the amplifier.

5 A system according to claim 1 wherein:

30 the processing subsystem modifies the phase information according to Cartesian feedback from the output signal from the amplifier.

6. A system according to claim 1 wherein:

the processing subsystem predistorts the phase modulation of the output signal according to the envelope information and feedback from the output signal.



7. A system according to claim 1 wherein:  
the processing subsystem predistorts the phase modulation of the output signal by  
modifying the phase information.

5 8. A system according to claim 1 wherein:  
the amplifier is part of the phase modulator.

JL

**PATENT COOPERATION TREATY**  
**PCT**  
**INTERNATIONAL PRELIMINARY EXAMINATION REPORT**  
(PCT Article 36 and Rule 70)

REC'D 29 OCT 2001

WIPO

PCT

Applicant's or agent's file reference ALCM:155266	<b>FOR FURTHER ACTION</b>	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
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VIII	<input type="checkbox"/> Certain observations on the international application																

Date of submission of the demand 19 April 2001	Date of completion of the report 18 October 2001
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer  <b>R.G. TOLHURST</b> Telephone No. (02) 6283 2187

**I. Basis of the report**

1. With regard to the elements of the international application:\*
- ☐ the international application as originally filed.
- ☒ the description, pages 1, 4-7 as originally filed,  
pages , filed with the demand,  
pages 2-3, received on 6 July 2001 with the letter of 6 July 2001
- ☒ the claims, pages , as originally filed,  
pages , as amended (together with any statement) under Article 19,  
pages , filed with the demand,  
pages 8-9, received on 6 July 2001 with the letter of 6 July 2001
- ☒ the drawings, pages 1/9-9/9, as originally filed,  
pages , filed with the demand,  
pages , received on with the letter of
- ☐ the sequence listing part of the description:  
pages , as originally filed  
pages , filed with the demand  
pages , received on with the letter of
2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.  
These elements were available or furnished to this Authority in the following language which is:
- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).
3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:
- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished
4. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/fig.
5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).\*\*

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. Statement**

Novelty (N)	Claims 1-8	YES
	Claims	NO
Inventive step (IS)	Claims 2-8	YES
	Claims 1	NO
Industrial applicability (IA)	Claims 1-8	YES
	Claims	NO

**2. Citations and explanations (Rule 70.7)**

As amended claim 1 defines arrangements in which the phase modulator includes: (i) a PLL which includes a frequency divider etc, or, alternatively, (ii) a quadrature modulator, otherwise not characterised. The latter configuration is considered to be non-inventive over the cited EP 360178, when read in view of what is well known in the field.

**VI. Certain documents cited****1. Certain published documents (Rule 70.10)**

Application No. Patent No.	Publication date (day/month/year)	Filing date (day/month/year)	Priority date ( valid claim) (day/month/year)
WO 99/54994	28 October 1999	29 September 1998	21 April 1998

**2. Non-written disclosures (Rule 70.9)**

Kind of non-written disclosure	Date of non-written disclosure (day/month/year)	Date of written disclosure referring to non- written disclosure (day/month/year)
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## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner  
US Department of Commerce  
United States Patent and Trademark  
Office, PCT  
2011 South Clark Place Room  
CP2/5C24  
Arlington, VA 22202  
ETATS-UNIS D'AMERIQUE  
in its capacity as elected Office

Date of mailing (day/month/year)  
18 June 2001 (18.06.01)

International application No.  
PCT/NZ00/00189

Applicant's or agent's file reference  
P425160 ALC

International filing date (day/month/year)  
29 September 2000 (29.09.00)

Priority date (day/month/year)  
29 September 1999 (29.09.99)

## Applicant

MANN, Stephen, Ian

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:  
19 April 2001 (19.04.01)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was  
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Nestor Santesso

Telephone No.: (41-22) 338.83.38